

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



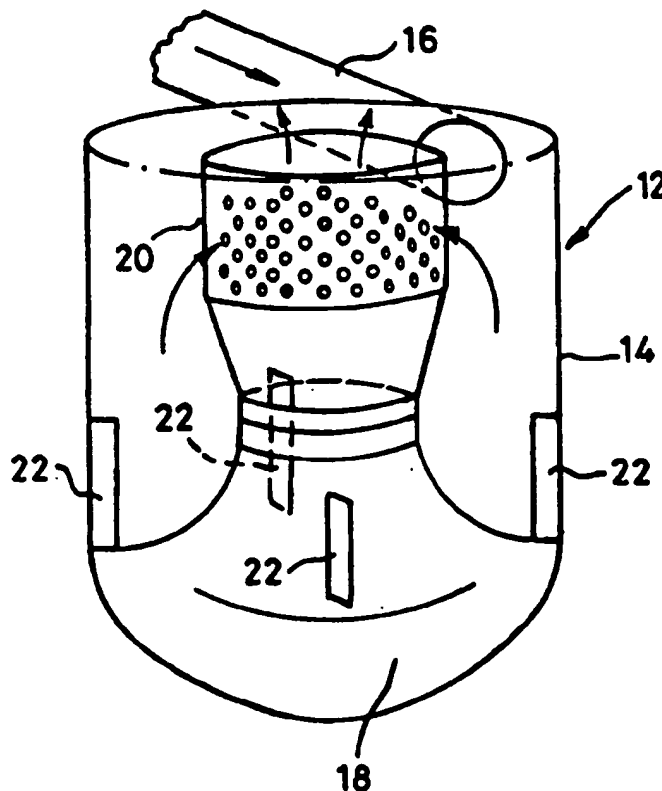
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : B04C 5/081, 5/14, A47L 9/16</p>	<p>A1</p>	<p>(11) International Publication Number: WO 96/27446 (43) International Publication Date: 12 September 1996 (12.09.96)</p>
<p>(21) International Application Number: PCT/GB96/00336 (22) International Filing Date: 13 February 1996 (13.02.96) (30) Priority Data: 9504505.0 7 March 1995 (07.03.95) GB (71) Applicant (for all designated States except US): NOTETRY LIMITED (GB/GB); Sycamore House, Bathford, Bath BA1 7RS (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): THOMSON, Andrew, Walter, McRae (GB/GB); Dyson Appliances Limited, Tetbury Hill, Malmesbury, Wiltshire SN16 0RP (GB). BICKERSTAFF, Simon, Mark (GB/GB); Dyson Appliances Limited, Tetbury Hill, Malmesbury, Wiltshire SN16 0RP (GB). (74) Agent: SMITH, Gillian, Ruth; Marks & Clerk, 57-60 Lincoln's Inn Fields, London WC2A 3LS (GB).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AZ, BY, KG, KZ, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report.</p>

(54) Title: IMPROVED DUST SEPARATION APPARATUS

(57) Abstract

Apparatus for separating dirt and dust entrained in an airflow therefrom, comprising a bin (12) having an outer wall (14) with a circular cross section, a tangential airflow inlet (16) for introducing the airflow to the bin (12) substantially tangentially to the outer wall (14), and an airflow outlet, wherein settling means (22), for encouraging dirt and dust collected in the bin (12) to settle, are provided inside the bin (12). Preferably, the settling means comprise inwardly extending projections, advantageously in the form of fins or baffles (22). This arrangement encourages dirt and dust separated from the airflow to remain in the bin (12) and discourages re-entrainment with the airflow.



BEST AVAILABLE COPY

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LJ	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

IMPROVED DUST SEPARATION APPARATUS

The invention relates to apparatus for separating dirt or dust particles from an airflow by cyclonic means. The invention relates particularly, but not exclusively, to cyclonic dust separation apparatus for use in a vacuum cleaner.

Cyclonic dust separation apparatus typically comprises an outer bin or container having a cylindrical or frusto-conical outer wall. A tangential air inlet supplies a dirty airflow to the interior of the bin or container such that the airflow is set into a swirling motion within the bin or container. By this swirling motion, dirt and dust particles are separated from the airflow and the particles collect in the lower portion of the bin or container whilst the airflow exits via an outlet located radially inwardly of the outer wall. Sometimes, the airflow is then passed to a second cyclone designed to separate from the airflow fine dust particles which are not separated in the first cyclone.

Vacuum cleaners incorporating such dust separation apparatus are known. However, it has been found that, when the height of the bin or container is reduced or when the bin or container becomes full of collected dirt and dust, then some of the separated dirt and dust can

become re-entrained in the airflow so that it passes out of the container again. When no second cyclone is provided the airflow exhausted from the bin or container carries with it more dirt and dust particles than is desirable. In cases where a second cyclone is provided, the re-entrained dirt and dust particles are separated from the airflow downstream of the bin or container but this then fills the collecting chamber of the second cyclone unacceptably quickly.

It is an object of the present invention to provide cyclonic dust separating apparatus wherein the risk of re-entrainment of separated dirt and dust into the airflow is reduced.

The invention provides apparatus for separating dirt or dust entrained in an airflow therefrom as set out in claim 1. Preferable and advantageous features of the invention are set out in the subsidiary claims. The invention also provides a vacuum cleaner comprising apparatus as set out in claims 1 to 18.

The provision of settling means inside the bin in the form of inwardly extending projections, particularly fins or baffles, encourages the separated dirt and dust to settle at the bottom of the bin. It is thought that pockets of relative stillness are created in the area of these projections which allow the separated dirt and dust to settle rather than becoming re-entrained into the airflow. Furthermore, experimentation has shown

that the provision of this type of settling means does not adversely affect the separation efficiency of the apparatus as a whole. However, the percentage of dirt and dust particles exiting from the bin or cylinder has been found to reduce in the presence of these settling means.

Embodiments of the invention will now be described with reference to the accompanying drawings wherein:

Figure 1a is a schematic perspective view of a bin or container forming part of dust separation apparatus according to the present invention;

Figure 1b is a schematic plan view of the bin or container shown in Figure 1a and illustrating the likely airflow pattern when the apparatus is in use;

Figure 2 is a sectional side view through a bin or container forming part of apparatus according to the invention;

Figures 3a and 3b are sectional side and plan views respectively of the bin or container shown in Figure 2 in use;

Figures 4a and 4b are vertical and horizontal partial sections through a first alternative fin; and

Figures 5a and 5b are horizontal sectional views through second and third alternative fins.

Figures 1a and 1b illustrate schematically the principle behind the present invention. Dust separating apparatus incorporates a bin or container 12 having an

outer wall 14 which has a circular cross-section. The bin or container 12 is normally generally cyclindrical in shape although conical or frusto-conical bins are not excluded. The bin 12 has an air inlet 16 which admits an airflow carrying dirt and dust particles into the bin or cylinder 12. The airflow enters the bin 12 tangentially so that the airflow adopts a swirling motion around the interior of the outer wall 14. By virtue of this swirling motion, the dirt and dust particles entrained within and carried by the airflow are separated out from the airflow and collect in the lower region 18 of the bin 12. The airflow moves towards the centre of the bin 12 and exits from the bin 12 by passing through small holes or perforations in a central shroud 20. The airflow then passes from the illustrated separation apparatus either direct to an exhaust port or to a second, high-efficiency cyclone for cyclonic separation of very fine dust particles which may remain in the airflow.

In order to prevent dirt and dust particles collected in the lower portion 18 of the bin 12 from becoming re-entrained into the airflow, fins or baffles 22 are arranged to project inwardly from the outer wall 14 into the interior of the bin 12. Four fins 22 are provided in the lower region 18 of the bin 12 and the fins 22 are equispaced about the circumference of the outer wall 14. As illustrated in Figure 1b it is

believed that the provision of these fins 22 creates pockets immediately on the upstream side of each fin 22 wherein the airflow is relatively still compared to the remainder of the interior of the bin 12. Small eddies may occur in these regions. Any dirt and dust particles which collect in these regions appear to remain separate from the main airflow and the dirt and dust particles are encouraged to settle and discouraged from becoming re-entrained in the main airflow.

Figure 2 shows in more detail a bin 12 which forms part of the separation apparatus according to the invention. The bin 12 has an outer wall 14 which is cylindrical in shape and has a handle 24 formed integrally therewith or attached thereto. The lower portion 18 of the bin 12 is frusto-conical in shape and forms a collector for a high-efficiency cyclone positioned upstream of the bin 12. An upstanding wall 26 mates with a frusto-conical fine dust collector (not shown) to form part of the high-efficiency cyclone.

Webs or fins 22 are positioned at the lower end of the outer wall 14 and project into the interior of the bin 12 from the outer wall 14. Each fin 22 has a generally horizontally extending upper edge 28 and a generally vertical inner edge 30. The fins 22 can be moulded integrally with the bin 12 or manufactured separately and fixedly attached thereto during the manufacturing process.

In the embodiment illustrated in Figure 2, four equispaced fins 22 are provided. Different numbers of fins 22 can be provided as desired. A plan view of the bin illustrated in Figure 2 is shown in Figure 3b. Figure 3a illustrates the bin 12 in use, and in particular in combination with high-efficiency cyclone apparatus located centrally inside the outer wall 14.

Tests have shown that the effect of the dust settling apparatus varies according to the dimensions of the fins 22. The effect has been found to be particularly advantageous if the fins 22 project into the bin 12 to a depth d of between 10mm and 40mm, particularly 20mm. Also, it has been found that the height h of the fins 22 is advantageously between 50mm and 100mm, particularly 66mm.

The shape of the fins 22 has also been found to affect the amount of dust which successfully settles in the lower region 18 of the bin 12. Figure 4 illustrates one embodiment of a fin 22. Both the upper edge 28 and the inner edge 30 are chamfered such that the sharp or acutely-angled edge lies on the upstream side of the fin 22.

Alternative embodiments are of course possible. Figure 5a is a horizontal cross-section through a web having a tongue 32 extending from the inner edge 30 of the fin 22 in the downstream direction. However, the preferred embodiment is illustrated in Figure 5b. In

this embodiment, the upper edge 28 is radiussed and the thickness of the fin 22 increases with distance from the upper edge 28. This is illustrated in Figure 2. Also, the inner edge 30 is partially chamfered and partially radiussed. In the lower region of the fin 22, the inner edge 30 has a chamfered portion 30' and a radiussed portion 30''. As the thickness of the fin 22 decreases in the vicinity of the upper edge 28, the size of the chamfered portion 30' decreases and, at or near the junction with the upper edge 28, the inner edge 30 becomes completely radiussed.

It will be appreciated by a skilled reader that adaptations and variations will achieve the same effect.

CLAIMS

1. Apparatus for separating dirt or dust entrained in an airflow therefrom, comprising a bin having an outer wall with a circular cross-section and a lower dirt-collecting area, a tangential airflow inlet for introducing the airflow to the bin substantially tangentially to the outer wall, and an airflow outlet, wherein settling means, in the form of a plurality of substantially planar projections extending radially inwardly from the outer wall, are provided inside the lower dirt-collecting area of the bin for encouraging dirt and dust collected in the bin to settle.
2. Apparatus as claimed in claim 1, wherein the projections are equispaced about the outer wall.
3. Apparatus as claimed in claim 1 or 2, wherein four projections are provided.
4. Apparatus as claimed in any one of the preceding claims, wherein the or each projection takes the form of a fin or baffle.
5. Apparatus as claimed in any one of the preceding claims, wherein the or each projection has an upper edge

which extends substantially perpendicular to the longitudinal axis of the bin.

6. Apparatus as claimed in claim 5, wherein the upper edge is radiussed.

7. Apparatus as claimed in claim 5, wherein the upper edge is chamfered.

8. Apparatus as claimed in any one of the preceding claims, wherein the or each projection has an inner edge which extends substantially parallel to the longitudinal axis of the bin.

9. Apparatus as claimed in claim 8, wherein the inner edge is at least partially chamfered.

10. Apparatus as claimed in claim 8 or 9, wherein the inner edge is at least partially radiussed.

11. Apparatus as claimed in any one of claims 8 to 10, wherein the inner edge has a tongue protruding from the downstream side thereof.

12. Apparatus as claimed in any one of the preceding claims, wherein the or each projection extends inwardly from the outer wall for between 10mm and 40mm.

13. Apparatus as claimed in claim 12, wherein the or each projection extends inwardly from the outer wall by substantially 20mm.

14. Apparatus as claimed in any one of the preceding claims, wherein the or each projection has a height of between 50mm and 100mm.

15 Apparatus as claimed in claim 14, wherein the or each projection has a height of between 60mm and 80mm.

16. Apparatus as claimed in claim 15, wherein the or each projection has a height of substantially 66mm.

17. Apparatus as claimed in any one of the preceding claims, wherein the outer wall of the bin is substantially cylindrical.

18. Apparatus substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

19. A vacuum cleaner comprising apparatus as claimed in any one of the preceding claims.

1 / 2

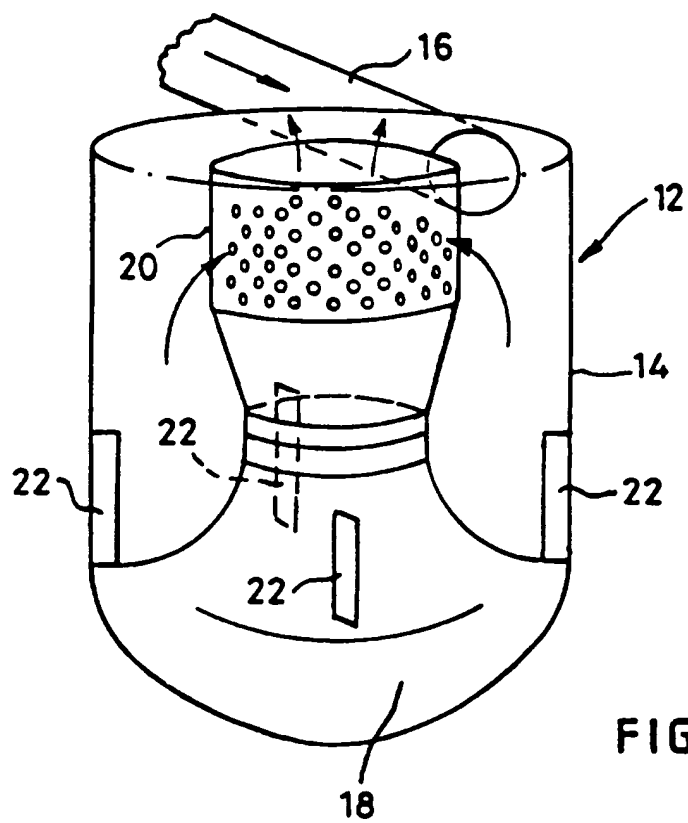


FIG. 1a

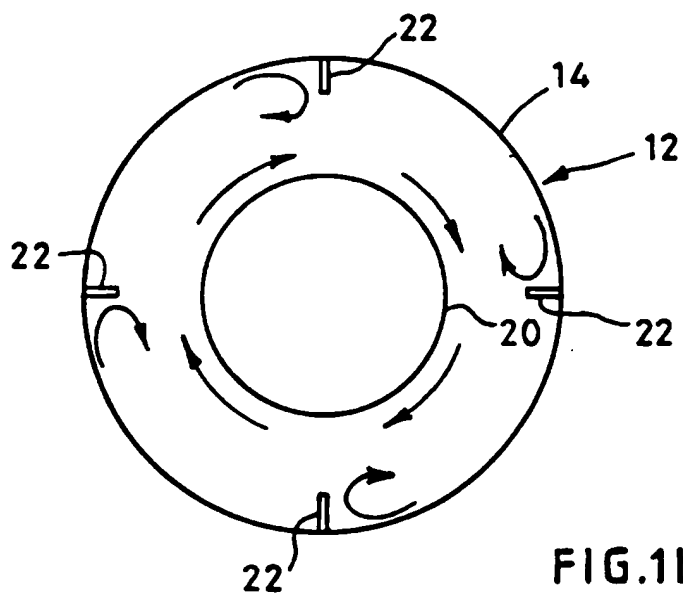
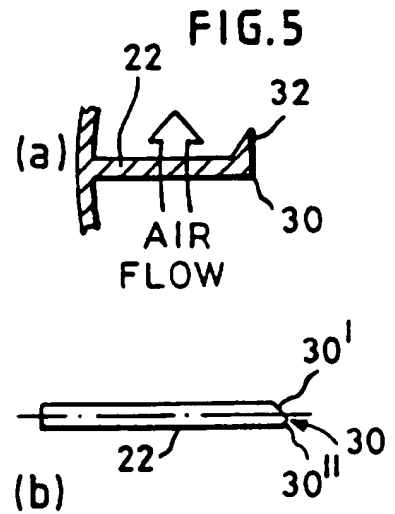
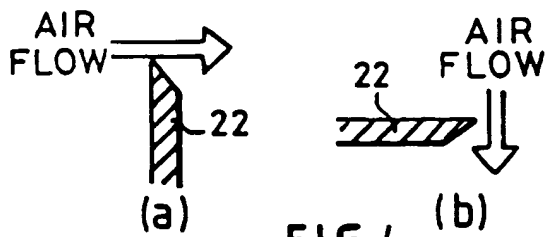
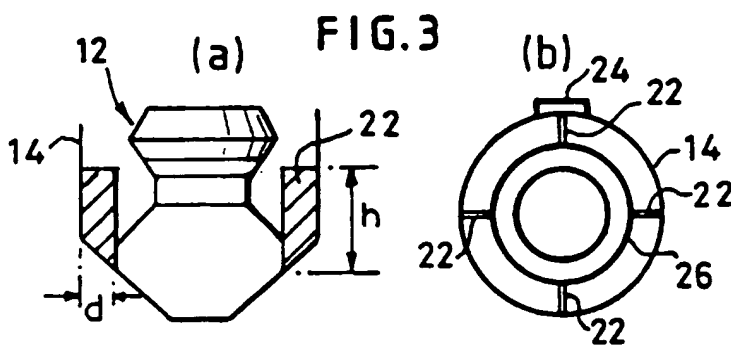
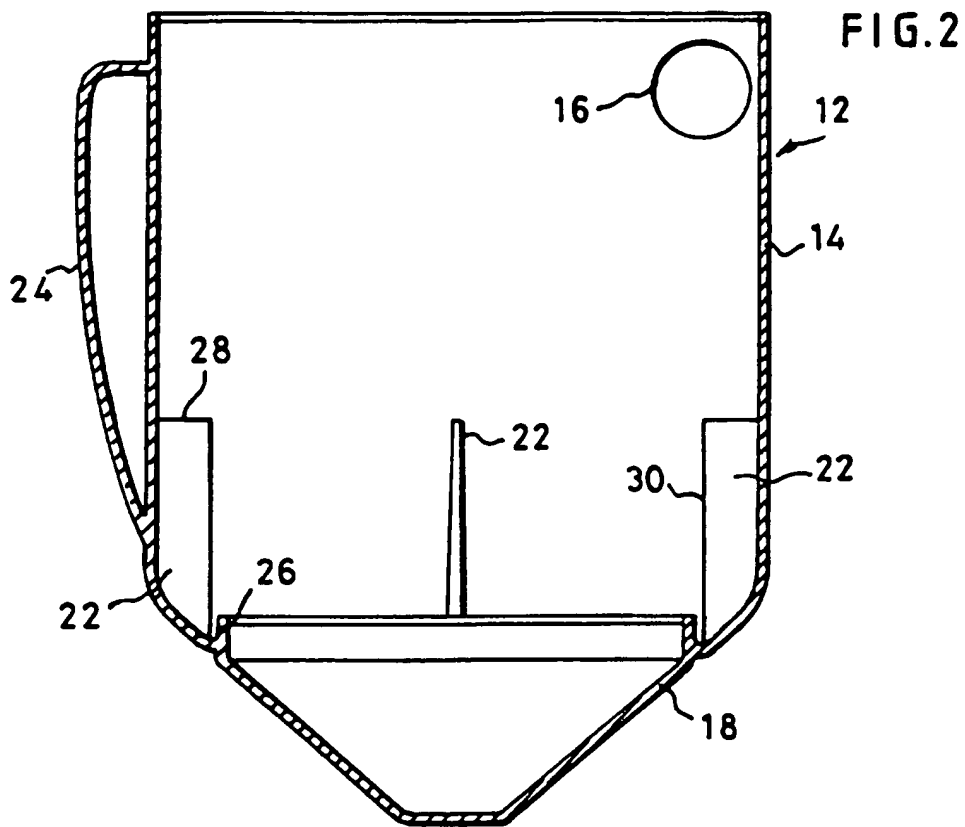


FIG. 1b



INTERNATIONAL SEARCH REPORT

Intern. Application No
PCT/GB 96/00336

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B04C5/081 B04C5/14 A47L9/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B04C A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,2 171 248 (VAN BERKEL) 29 August 1939 see page 2, left-hand column, line 29 - line 61 see page 2, right-hand column, line 16 - page 3, left-hand column, line 11; figures ---	1-5, 7-10, 12-17,19
X	DE,C,754 339 (FREEMAN) 25 October 1951 see page 7, line 52 - line 65; figures -----	1,2,4-8, 17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *A* document member of the same patent family

Date of the actual completion of the international search

8 May 1996

Date of mailing of the international search report

17.05.1996

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+ 31-70) 340-3016

Authorized officer

Van der Zee, W

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB96/00336

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 18
because they relate to subject matter not required to be searched by this Authority, namely:
see PCT-Rule 6.2(a)
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No

PCT/GB 96/00336

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-2171248	29-08-39	NONE	

DE-C-754339		BE-A- 420877	
		BE-A- 426877	
		GB-A- 507412	
		US-A- 2102525	14-12-37

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☒ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.